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BOOK REVIEW

The Poetry of Reproduction

Beverley Glover, Understanding Flowers and Flowering. An Integrated Approach, 2007, Oxford University Press, x + 227 pp, £XX, ISBN: 978-0-19-856597-0

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> *The flower is the poetry of reproduction. It is an example of the eternal seductiveness of life.*
> Jean Giraudoux, The Enchanted (1933)

Flowers are not only "example of the eternal seductiveness of life" but flowers are also fascinating in their own rights, and "Understanding Flowers and Flowering" is an intellectually seductive journey into the fascinating world of plant reproduction (Fig. 1). Did you ever wonder how flowers might have evolved? What the German poet Johann Wolfgang von Goethe has to do with flowers? Which signalling pathways induce flowering? What happens at the shoot apical meristem after floral induction? How do flowers develop? What are the D and E in the ABC model? Which strategies exist to prevent self-pollination? How can flower development be modified to change floral shape and structure? What makes flowers so colourful? What kind of pollen vectors can mediate cross-pollination? Are flowers under selective pressure to increase attractiveness for pollinators? Do pollinators differentiate between different floral forms, colours or scents? Many of these questions have been discussed in the context of "pollination syndromes", i.e. the matching adaptation of certain flowers and specific pollinators caused by coevolution. But what is the evidence that pollination syndromes really exist? To find answers to these and many other questions you should read this book!

"Flowers and Flowering" delivers a detailed discussion of flowering time control including a chapter about historical development of the flowering concept. Surprisingly, the famous Maryland Mammoth tobacco is never mentioned, and William Garner's and Harry Allard's desperate 12-year-long search for the physiological signal that allows flowering is not mentioned. It was not pure scientific curiosity but the great economic impact a non-flowering tobacco could have that drove the first systematic and detailed analysis of flowering control eventually establishing the concept of photoperiodic control of flowering (Garner and Allard 1920). Anecdotal information could also have enriched the chapter about the famous foliar theory originally proposed by Goethe (Goethe 1790). As pointed out in the book, Goethe thought of all plant organs analogous to a single type organ (the *Blatt* = leaf), but he did not imply any evolutionary or developmental concept. Thus, while we think that petals are organs derived from leaves, he thought of petals and leaves as different manifestations of a single idea – the *Blatt*. It has been argued that this view of Goethe is essentially idealistic (Platonian) (May 1913), and the deleterious consequences of idealistic philosophy for the idea of evolution to become generally accepted has been discussed in detail (Mayr 1982). Philosophical idealisms led Goethe to propose the foliar theory, and philosophical idealisms prevented Goethe from seeing the developmental and evolutionary interpretation of the foliar theory. While focussing on the foliar theory, another revolutionary aspect is often overlooked: Goethe used mutants to derive his conclusions! While his contemporary naturalists were convinced that in order to understand the normal, one has to study the normal, Goethe proposed to study "freaks" to understand the normal. He used floral mutants, selected by gardeners for their ornamental value such as filled roses, to derive conclusions about normal development. Much later developmental genetics led to the discovery of homeotic transformations and the basic mechanisms of flower development, and these results are described in several detailed chapters in "Flowers and Flowering".

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Fig. 1 The wonderful world of flowers. (Images from Botanische Bilddatenbank, www.unibas.ch/botimage/)

Plant reproduction—from flowering time control to pollination—is a rapidly evolving field. For a textbook, "Flowers and Flowering" is refreshingly up-to-date and refers to many recent primary research papers (e.g. Abe et al. 2005; Corbesier et al. 2007; Dyer et al. 2006; Friedman 2006; Goldraij et al. 2006; Schönrock et al. 2006; Tamaki et al. 2007). The book gives detailed insights in the current conceptual frameworks developed within the fields of molecular and developmental genetics, ecology and evolutionary biology. Being written by a single author and not compiled by an editor greatly improves readability and digestibility of the book. Almost unavoidable for such a wide synthesis of molecular and ecological data, some minor flaws went undetected: The statement that

vernalization is usually sensed by leaves and occasionally also by shoot apices, for instance, is not reflecting the current consensus of the field. To the contrary, it is believed that vernalization acts mainly on shoot apices, and on leaves only as much as they still contain proliferating cells (see e.g. Finnegan et al. 2007; Wellensiek 1962; Wellensiek 1964). Another detail, important for the colleagues in the field but less so for the average reader, is that the credit for the late flowering Arabidopsis *constans* mutant should go to Georg Redei (Redei 1962) and not to Marten Koornneef's seminal paper on Arabidopsis flowering time mutants (Koornneef et al. 1991).

The subtitle of this book is *An integrated approach*, and the author managed to unite fields that often appear incompatible. Molecular genetics of flowering time control and flower development were mostly worked out using *Arabidopsis thaliana* as a model species, while mostly self-pollinating Arabidopsis is of no use when studying the pollination syndromes. Nonetheless, insects visit Arabidopsis, and there can be up to 1% out-crossing (Hoffmann et al. 2003; Tan et al. 2005). The "integrative" side of the book would benefit by including some information on insect pollination of Arabidopsis!

Despite these comments, this is a very carefully written, detailed and up-to-date book. It can be recommended as a text book for courses at the master's level and for PhD courses alike. It can also help the specialist to get a quick overview about this expanding field. Finally, it is a great pleasure to read just for the love of flowers!

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References

Abe M, Kobayashi Y, Yamamoto S, Daimon Y, Yamaguchi A, Ikeda Y, Ichinoki H, Notaguchi M, Goto K, Araki T (2005) FD, a bZIP protein mediating signals from the floral pathway integrator FT at the shoot apex. Science 309:1052–1056

Corbesier L, Vincent C, Jang S, Fornara F, Fan Q, Searle I, Giakountis A, Farrona S, Gissot L, Turnbull C, Coupland G (2007) FT Protein movement contributes to long-distance signaling in floral induction of Arabidopsis. Science 316:1030–1033

Dyer AG, Whitney HM, Arnold SE, Glover BJ, Chittka L (2006) Behavioural ecology: bees associate warmth with floral colour. Nature 442:525

Finnegan EJ, Dennis ES (2007) Vernalization-induced trimethylation of Histone H3 Lysine 27 at *FLC* is not maintained in mitotically quiescent cells. Curr Biol 17:1978–1983

Friedman WE (2006) Embryological evidence for developmental lability during early angiosperm evolution. Nature 441:337–340

Garner WW, Allard HA (1920) Effect of the relative length of day and night and other factors of the environment on growth and reproduction in plants. J Agric Res 18:553–606

Goethe JW (1790) Versuch die Metamorphose der Pflanzen zu erklären. C.W. Ettinger, Gotha, Germany

Goldraij A, Kondo K, Lee CB, Hancock CN, Sivaguru M, Vazquez-Santana S, Kim S, Phillips TE, Cruz-Garcia F, McClure B (2006) Compartmentalization of S-RNase and HT-B degradation in self-incompatible Nicotiana. Nature 439:805–810

Hoffmann M, Bremer M, Schneider K, Burger F, Stolle E, Moritz G (2003) Flower visitors in a natural population of *Arabidopsis thaliana*. Plant Biol 5:491–494

Koornneef M, Hanhart CJ, van der Veen JH (1991) A genetic and physiological analysis of late flowering mutants in *Arabidopsis thaliana*. Mol Gen Genet 229:57–66

May W (1913) Der Sinn der Pflanzenmetamorphose bei Goethe. Naturwissenschaften 1:982–985

Mayr E (1982) The growth of biological thought. Diversity, evolution and inheritance. Belknap Press of Harvard University Press, Cambridge, Mass, and London

Redei GP (1962) Supervital mutants of Arabidopsis. Genetics 47:443–460

Schönrock N, Bouveret R, Leroy O, Borghi L, Köhler C, Gruissem W, Hennig L (2006) Polycomb-group proteins repress the floral activator *AGL19* in the *FLC*-independent vernalization pathway. Genes Dev 20:1667–1678

Tamaki S, Matsuo S, Wong HL, Yokoi S, Shimamoto K (2007) Hd3a protein is a mobile flowering signal in rice. Science 316:1033–1036

Tan YY, Xu HH, Tao WJ, Hoffmann MH, Wang XF, Lu YT (2005) Transgenic GFP as a molecular marker for approaches to quantify pollination mechanism and gene flow in *Arabidopsis thaliana*. Plant Biol (Stuttg) 7:405–410

Wellensiek SJ (1962) Dividing cells as the locus for vernalization. Nature 195:307–308

Wellensiek SJ (1964) Dividing cells as the prerequisite for vernalization. Plant Physiol 39:832–835